Energy relaxation at the quantum Hall edge

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In this work we address recent experiment [1] of Altimiras and collaborators, where an electron distribution function at the quantum Hall (QH) edge at filling factor $\nu = 2$ has been measured with high precision. It has been reported that the energy of electrons injected into one of the two chiral edge channels with the help of a quantum point contact (QPC) is equally distributed between them, in agreement with earlier predictions, one being based on the Fermi gas approach [2] and the other utilizing the Luttinger liquid theory [3]. We predict that the physics of the energy relaxation process at the QH edge may in fact be more rich, providing the possibility for discriminating between two physical pictures in experiment. Namely, using the recently proposed non-equilibrium bosonization technique [4], we evaluate the electron distribution function and find that the initial "double-step" distribution created at a QPC evolves through several intermediate asymptotics, before reaching eventual equilibrium state. At short distances the distribution function is found to be strongly asymmetric due to non-Gaussian current noise effects. At larger distances, where noise becomes Gaussian, the distribution function acquires symmetric Lorentzian shape. Importantly, in the regime of low QPC transparencies T the width of the Lorentzian scales linearly with T, in striking difference with the equilibrium Fermi distribution, whose width scales as $\sqrt{T}$. Therefore, we propose to do measurements at low QPC transparencies.

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[4] I.P. Levkivskyi, E.V. Sukhorukov, Phys. Rev. Lett. 103, 036801 (2009)